Total Maximum Daily Loads
for
Kirkman's Cove Lake – Richardson County, Nebraska

Parameters of Concern: Dissolved Oxygen and Nutrients

Pollutant Addressed: Phosphorus

Nebraska Department of Environmental Quality
Planning Unit, Water Quality Division

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Executive Summary

Kirkman's Cove Lake was included on the 1998 Nebraska Section 303(d) List of Impaired Waters (NDEQ 1998) due to impairment by pesticides (atrazine), arsenic, nutrients and low dissolved oxygen/organic enrichment. As such, total maximum daily loads must be developed in accordance with the Clean Water Act. This document presents a TMDL, for phosphorus to address low dissolved oxygen/organic enrichment and nutrient impairments. The information contained herein should be considered 2 TMDLs based upon the reduction of a single pollutant (phosphorus).

Revisions to Title 117 – Nebraska Surface Water Quality Standards criteria will allow the de-listing of Kirkman's Cove Lake for impairment caused by pesticides and arsenic and therefore it is not necessary to address these pollutants. The de-listing has been included on the proposed 2002 Nebraska Section 303(d) list.

These TMDLs have been prepared to comply with the current (1992) regulations found at 40 CFR Part 130.7.

1. **Name and geographic location of the impaired waterbody for which the TMDL is being developed.**
   Kirkman's Cove Lake, Section 32, T 3 North, R 13 East, Richardson County, Nebraska. Lat. 40° 11' 00", Long. 95° 59' 15"

2. **Identification of the pollutant and applicable water quality standard**
   The pollutant causing the impairment(s) of the water quality standard and designated beneficial use is nutrients (phosphorus). Designated uses assigned to Kirkman's Cove Lake include: primary contact recreation, aquatic life Warmwater class A, agriculture water supply class A and aesthetics (NDEQ 2000). Excessive nutrient inputs have been determined to be impairing the aesthetic and aquatic life beneficial uses.

3. **Quantification of the pollutant load that may be present in the waterbody and still allow attainment and maintenance of the water quality standards.**
   Empirical data and the EUTROMOD water quality model were employed to determine the current and maximum nutrient load that if achieved should result in beneficial use attainment. This value is 292.8 lbs/year (133 kg/year) for phosphorus.

4. **Quantification of the amount or degree by which the current pollutant load in the waterbody, including upstream sources that is being accounted for as background loading deviates from the pollutant load needed to attain and maintain water quality standards.**
   The total phosphorus load delivered to Kirkman's Cove Lake is estimated to be 3463.4 lbs/year. To meet the water quality goals, the average annual loading capacity is 292.8 lbs/year. To achieve the loading capacity an approximate 92% reduction is needed.

5. **Identification of the pollution source categories.**
   Nonpoint and natural sources of nutrients have been identified as the cause of impairment to Kirkman's Cove Lake.

6. **Wasteload allocations for pollutants from point sources.**
   No point sources discharge in the watershed and therefore the wasteload allocation will be set at zero (0).

7. **Load allocations for pollutants from nonpoint sources.**
   For this TMDL the phosphorus load allocation is set at 240 lbs/year. The allocation was developed using the EUTROMOD model. The load allocation for natural sources is 52.8 lbs/year and was also determined using the EUTROMOD model.

8 **A margin of safety.**
This TMDL contain an implicit margin of safety. Pollutants are discharged from the system via the reservoir's outlet. The TMDL will assume all pollutants delivered to the waterbody remain, again reflecting a worst-case condition.

9. **Consideration for seasonal variation.**
The pollutants of concern are delivered on a year round basis and the assessment of the data considers annual average conditions. However, in-lake and watershed model inputs require that seasonal changes (e.g. vegetative cover, precipitation) be accounted for. Because nonpoint sources have been identified as the largest contributor, management practices and implementation will be targeted at those times when the nonpoint source influence is the greatest. This usually revolves around the precipitation events of mid to late spring when there is a high potential for run-off of sediment, phosphorus (attached to sediment), and nitrogen. The effects of the excess pollutant loadings are: large quantities of algae growth occurring during the growing season, potential for future dissolved oxygen impairments and sediment reducing the volume of the lake.

10. **Allowances for reasonably foreseeable increases in pollutant loads.**
There was no allowance for future growth included in these TMDLs.

11. **Implementation Plan**
Implementation of the reductions for the pollutant is currently underway for Kirkman's Cove Lake and is comprised of 2 phases: 1) in-lake structures and 2) watershed treatment. The in-lake structures have been completed and the watershed treatments will be pursued in the near future. To facilitate implementation of the watershed work, the Nebraska Department of Environmental Quality has committed Section 319 funds for the Nemaha Natural Resource District to support a watershed coordinator to be responsible for overseeing the implementation of the community based watershed management plan.

The TMDL(s) included in the following text can be considered "phased TMDLs" and as such are an iterative approach to managing water quality based on the feedback mechanism of implementing a required monitoring plan that will determine the adequacy of load reductions to meet water quality standards and revision of the TMDL in the future if necessary. A description of the future monitoring (Section 4.0) that is planned has been included.

Monitoring is essential to all TMDLs in order to:

- Assess the future beneficial use status;
- Determine if the water quality is improving, degrading or remaining status quo;
- Evaluate the effectiveness of implemented best management practices.

The additional data collected should be used to determine if the implemented TMDL and watershed management plan have been or are effective in addressing the identified water quality impairments. As well the data and information can be used to determine if the TMDLs have accurately identified the required components (i.e. loading/assimilative capacity, load allocations, in lake response to pollutant loads, etc.) and if revisions are appropriate.

1.0 Introduction

Kirkman's Cove Lake was listed on the 1998 Nebraska Section 303(d) list of impaired waters (NDEQ 1998) as not supporting the assigned beneficial uses with the pollutants of concern being, atrazine (pesticides), arsenic, nutrients, and low dissolved oxygen.

For the 1998 atrazine listing, the applicable water quality criteria applied for was 1 μg/l, which was intended to protect aquatic life during chronic exposures. In 1999, the Nebraska Department of Environmental Quality (NDEQ) proposed and received approval to change the chronic water quality standard found in Title 117 – Nebraska Surface Water Quality Standards (Title 117) from 1 μg/l to 12 μg/l. Using this new standard, the NDEQ's assessment procedures and the existing data, Kirkman's Cove Lake was re-assessed and determined not to be impaired due to atrazine. Therefore, for the 2002 Section 303(d) listing, the parameter will be removed and no total maximum daily load (TMDL) will be developed for atrazine.

Similarly, in 1999 the chronic water quality standard for arsenic was changed from 1.4 μg/l to 16.7 μg/l. Using the modified arsenic standard, assessment procedures and existing data, the waterbody was re-assessed and determined not to be impaired due to arsenic. This parameter too will be de-listed in 2002 and no TMDL will be developed for arsenic.

In reservoirs, dissolved oxygen impairments can be the result of accelerated eutrophication. Excessive algae and macrophyte growth add to the oxygen demand. Control of the nutrients should in turn have an affect on the plant growth, which then will affect the oxygen demand. Therefore, based on the above and as required by Section 303(d) of the Clean Water Act and 40 CFR Part 130.7, a TMDL for nutrients has been developed and contained herein to address the nutrient(s) and low dissolved oxygen impairments.

1.1 Background Information

Kirkman's Cove Lake is located in Richardson County, Nebraska (Figure 1) and was constructed as one of the Long Branch Watershed Project Structures by the Nemaha Natural Resource District (NNRD) who maintains ownership of the structure. Kirkman's Cove Lake was designed as a multi-purpose flow retarding and recreation structure (NNRD 1994) with the completion of the dam and lake occurring in 1986. A description of the physical information is provided in Table 1.1. The Nebraska Game and Parks Commission (NGPC) manage the fishery and the NNRD manages the immediate surrounding 351 acres as a recreation facility. No towns exist within the watershed boundary however, Humbolt (population 941) lies approximately 2.5 miles to the southeast.

1.1.1 Waterbody Description

1.1.1.1 Waterbody Name: Kirkman's Cove Lake

Lake Identification Number: NE2-L0040 (Tile 117 – Nebraska Surface Water Quality Standards)

1.1.1.2 Major River Basin: Missouri River

1.1.1.3 Minor River Basin: Nemaha

1.1.1.4 Hydrologic Unit Code 10240008

1.1.1.5 Assigned Beneficial Uses: Primary contact recreation, Aquatic Life Warmwater Class A, Agricultural Water Supply Class A and Aesthetics (Title 117 – Nebraska Surface Water Quality Standards) (NDEQ 2000).

1.1.1.6 Major Tributary: Kirkham Creek – NE2-12331

Figure 1.1 Location of Kirkman's Cove Lake and Watershed in Richardson and Pawnee County, Nebraska

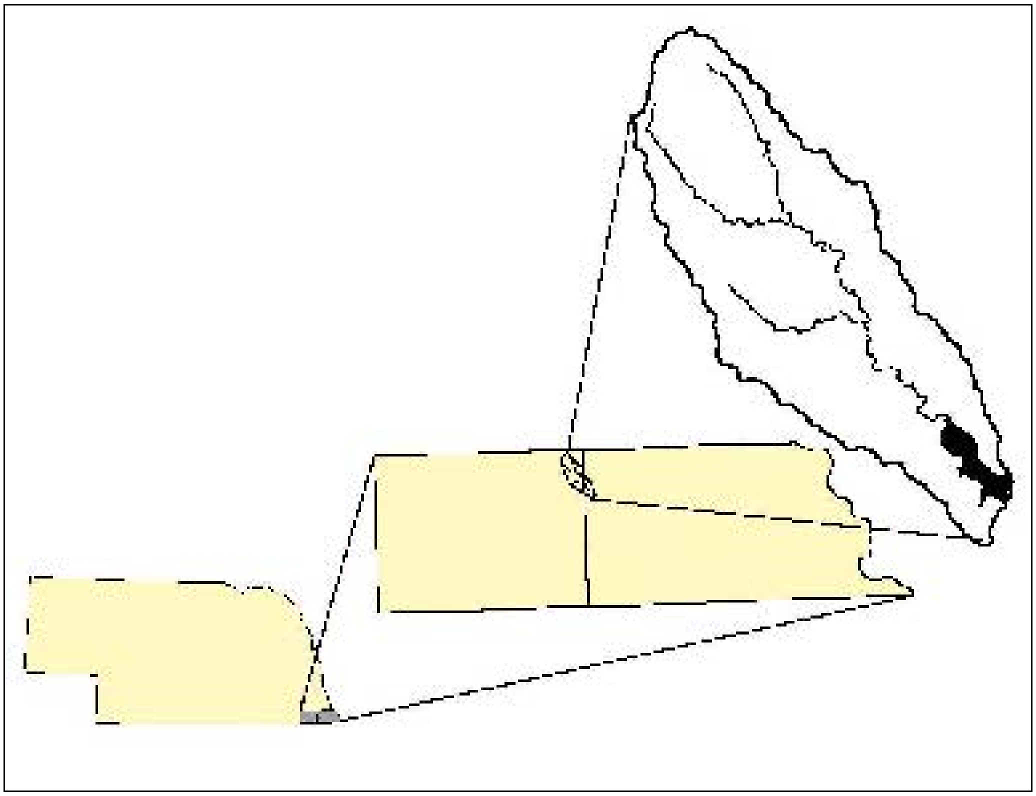


Table 1.1 Physical Description of Kirkman's Cove Lake

Parameter	Kirkman's Cove Lake
State	Nebraska
County	Richardson
Latitude (center of dam)	40° 11' 00"
Longitude (center of dam)	95° 59' 15"
Section, Township, Range (dam)	Section 32, T 3 North, R 13 East
Surface Area – 1986	160 acres
Surface Area – 2001	141.2
Shoreline length (approximate)	3.5 miles
Mean Depth – 1986	9.8 feet (3 meters) (suspect, based on "as built plans)
Mean Depth – 2001	10.32 (3.15 meters)
Conservation Pool Volume – 1986	1,569 acre-feet (suspect, based on "as built plans)
Conservation Pool Volume – 2001	1,457.8 arce-feet
Number of Major Inlets	1
Watershed Area	5,882 acres
Lake to Watershed Area Ratio	1:42

1.1.2 Watershed Characterization

1.1.2.1 Physical Features: Kirkman's Cove Lake has a watershed of approximately 5,882 acres and is located in the Western Corn Belt Plains (Level III) ecoregion as defined by Chapman, et al. (2001). The reservoir was completed in 1986 by the NNRD who retains ownership however; the lake's fishery is managed by the NGPC. The watershed is rural and general agriculture (e.g. row crops, pasture) dominating the land use with lesser amounts of homesteads and wooded areas.

Kirkham Creek – NE2-12331 is the only tributary and enters the lake from the north/northwest. The land surface in watershed consists of rolling hills that descend to flat valleys. Drainage in the valleys is poor in some areas but well defined with rapid surface runoff in the remainder of the watershed (NNRC 1976). Soil associations in the watershed include the Kennebec-Judson-Wabash, Wymore and Morrill-Pawnee-Mayberry. Soils of the Kennebec-Judson-Wabash association are deep, nearly level to gently sloping, well-drained silty soils and poor drained clayey soils and are considered bottomland soils. The soils of the Wymore association are deep; nearly level to strongly sloping moderately well drained that have a silty surface layer and a clayey subsoil. The soils of the Morrill-Pawnee-Mayberry association are deep gently sloping to moderately steep well drained and moderately well drained loamy soils that have a loamy or clayey subsoil. The latter two associations are considered upland soils (Sautter, et. al. 1974).

1.1.2.2 Climate: Winters in the watershed are cold with precipitation mainly occurring as snowfall. Summers can be hot but with occasional cool spells. Annual precipitation in the area is approximately 33 inches (DNR Data bank). The majority of the precipitation occurs during the growing season.

1.1.2.3 Demographics: While no municipality lies in the watershed, the (second class) City of Humboldt – Population 941 – lies approximately 2.5 miles to the southeast. Humboldt has seen an approximate 6% population decrease over the last ten years.

1.1.2.4 Land Uses: Agriculture dominates the land use in the watershed with the 1992-3 estimates being 53% being devoted to cropland, 27% pasture and grass, 15% enrolled in the Conservation Reserve Program and the remaining 5% being homesteads, water and wooded areas (NNRD 1994). An aerial photograph of the watershed is provided in Figure 1.1.2.4.

2.0 Nutrient TMDL to Address Nutrient and Low Dissolved Oxygen/Organic Enrichment Impairments

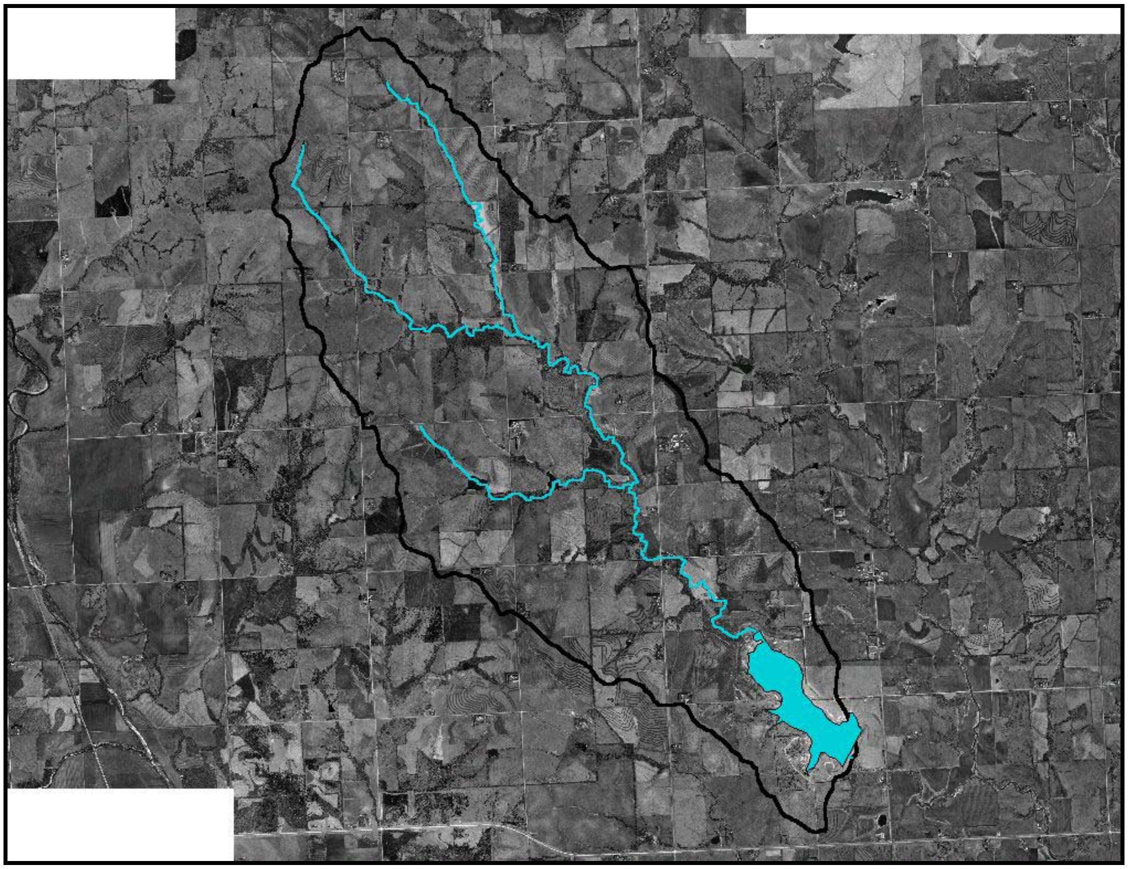
2.1 Problem Identification

Kirkman's Cove Lake was included on the 1998 Section 303(d) list as being impaired by excessive nutrients and low dissolved oxygen. In-lake conditions indicate accelerated eutrophication caused by excessive nutrient loading. The linkage between accelerated eutrophication and water quality impairments has been repeatedly documented (USEPA 1999). Eastern Nebraska reservoirs classified as being eutrophic or hypereutrophic are generally high in phosphorus, particularly in agricultural watersheds that produce high sediment yields. Kirkman's Cove Lake watershed modeling and in-lake conditions have resulted in phosphorus being the targeted parameter of concern. The following sections detail the extent and nature of the water quality impairments related to accelerated eutrophication in Kirkman's Cove Lake.

2.1.1 Water Quality Impairments

Kirkman's Cove Lake assigned beneficial uses for Warmwater A (WWA) Aquatic Life was listed as impaired based upon assessment of the available data to the applicable (WWA) dissolved oxygen criteria (5.0 mg/l) being violated (NDEQ 1998).

Figure 1.1.2.4 Aerial Photograph of Kirkman's Cove Lake and Watershed



2.1.2 Data Sources

The NNRD and NDEQ have collected various water quality data and information on a semi-regular basis mainly from 1992 through 2001. NDEQ will continue to collect such information in accordance with basin rotation pre- and post-project monitoring and other priorities. The existing data includes, water transparency, dissolved oxygen, temperature, conductivity, pH, pesticides, chlorophyll *a*, nitrogen series, dissolved and total phosphorus and total suspended solids.

2.1.3 Water Quality Data Assessment

Beneficial use assessment procedures utilized in preparing the 1998 Section 303(d) list of impaired waters for dissolved oxygen require that concentrations be measured in a "top-to-bottom" profile above the stratified layer. Measurements are then averaged and compared to the 1-day minimum aquatic life criteria of 5.0 mg/l, applicable from April 1 to September 30 (NDEQ 2000). Should greater than 10% of the profile averages fall below the criteria, the waterbody was considered to be partially supporting the *Aquatic Life* WWA beneficial use and thus included on the Section 303(d) list.

Nebraska currently does not have numeric water quality criteria for nutrients however; a biomass trophic state index (TSI) (Carlson 1977; Carlson and Simpson 1996) is used as the metric for evaluating this source/stressor. TSI's calculated from transparency (secchi depth), chlorophyll *a,* and total phosphorus concentration data, were also utilized to infer whether algal growth was nutrient or light limited (if the three indices are approximately equal, it can be inferred that algal growth is phosphorus limited (USEPA 1999)). Finally, the average of the three TSI scores is used as a single measure of lake conditions (e.g., oligotrophic, mesotrophic, eutrophic or hypereutrophic) as described in Carlson and Simpson (1996). The following classification is used to interpret the TSI:

Trophic State Index Score	**Trophic Status**	**Assessment Criteria**	**NDEQ Beneficial Use Attainment Status**
<40	Oligotrophic	2 of 3 parameters	Full Support
>35 but <45	Mesotrophic	2 of 3 parameters	Full Support
>45	Eutrophic	2 of 3 parameters	Full Support
>60	Hypereutrophic	2 of 3 parameters	Partial Support

2.1.3.1 Water Quality Conditions

Nine growing season (May through September) dissolved oxygen profiles were available for Kirkman's Cove Lake from 1995-1998. Assessments of the profiles indicate two (2) of the average concentrations were less than 5.0 mg/l for a 22% excursion rate.

Trophic State Indices scores for Kirkman's Cove Lake using average growing season in-lake data collected from 1993-2001 are presented in Table 2.1.3.1.

Table 2.1.3.1 Long Term Growing Season Conditions for Kirkman's Cove Lake

Parameter	**In-Lake Average Value**	**TSI Score**
Secchi depth (meters)	0.42	72.5
Chlorophyll *a* (mg/m^3)	12.2	55.1
Total Phosphorus (μg/l)	205.7	81.0
Mean TSI		**69.5**

With a mean TSI score of 69.5, the waterbody is considered hypereutrophic and because at least 2 of the 3 parameters are greater than the hypereutrophic threshold, the waterbody is considered partially supporting the aesthetic and aquatic life beneficial uses.

One interpretation of the TSI scores (TSI–total phosphorus and TSI-secchi depth >TSI-chlorophyll *a* is that non-algal particulates (total suspended solids) prohibit algal growth. The data set indicates in-lake total suspended solids concentrations to range from 5 to 293 mg/l with a mean of 47 mg/l. Also, conservative volume estimates from 1986 and 1999 indicate the annual sedimentation rate to be 0.55%/year.

While algae production may be interpreted to be "light limited", measured in-lake phosphorus concentrations are similar to or greater than the concentrations measured in southeastern Nebraska lakes where phosphorus is the limiting parameter. Therefore, phosphorus has been determined to be the parameter targeted for reduction to address both the nutrient and dissolved oxygen impairments. It should be noted, although phosphorus is the nutrient targeted for reduction, the controls implemented to reduce phosphorus should also reduced nitrogen (and other nutrient) contributions.

2.1.4 Potential Pollutant Sources

2.1.4.1 Point Source: No point sources, permitted under the National Pollutant Discharge Elimination System (NPDES) program have been identified in the Kirkman's Cove Lake watershed. There are two confined animal feeding operations that have been issued State of Nebraska operating permits however; these are "no discharge" permits.

2.1.4.2 Nonpoint Sources: Multiple nonpoint phosphorus sources have been identified in the Kirkman's Cove Lake watershed that includes: stream bank and gully erosion, agricultural, and other land uses (i.e., grasslands, wooded, etc.).

2.1.4.3 Natural Sources: Natural background/sources was based upon the contribution of phosphorus as estimated by EUTROMOD modeling techniques.

2.2 TMDL Endpoint

The endpoint for the nutrient and dissolved oxygen TMDL is based upon both narrative and numeric criteria and stakeholder defined water quality goals. As described below, phosphorus loading targets in comparison with current load estimates allowed for the determination of an acceptable load (desired endpoint) and the needed reduction necessary to attain full support designation and the stakeholder-defined goals.

2.2.1 Criteria for Assessing Water Quality Attainment

2.2.1.1 Numeric Water Quality Criteria: The1-day minimum dissolved oxygen criteria of 5.0 mg/l associated with the WWA – Aquatic life beneficial use is the applicable numeric water quality criteria.

2.2.1.2 Quantification of Narrative Water Quality Criteria: As previously outlined in Section 2.1.3, Nebraska does not have numeric water quality standards for nutrients. However, Nebraska's water quality standards for "Aesthetics" states in part, "To be aesthetically acceptable, waters shall be free from human-induced pollution which causes floating, suspended, colloidal, or settleable materials that produce objectionable films, colors, turbidity, or deposits (NDEQ 2000).

The application of the "Aesthetics" beneficial use is through the assessment of a lake's trophic status using Carlson's trophic state index (TSI) as described in Section 2.1.3. In order for a water body to achieve a "full support status", 2 of 3 TSI parameters must be less than 60. Those conditions are presented in Table 2.2.1.2.

Table 2.2.1.2 Kirkman's Cove Lake Water Quality Goals to Attain Beneficial Uses

TSI Parameter	Desired In-Lake Condition (growing season)	TSI Score	Mean TSI Score
Transparency (Secchi depth)	39 inches (0.99 meters)	60	****
Chlorophyll *a*	20.0 mg/m^3	60	****
Total phosphorus	48 μg/l	60	****
			60

2.2.1.3 Local Stakeholder Defined Goals: Through stakeholder meetings held in the Kirkman's Cove Lake watershed, in-lake water quality goals were established. The desired conditions are presented in Table 2.2.1.3. It should be noted; the stakeholder defined goals were based on meeting a TSI of 70, which was previously defined as the hypereutrophic threshold.

Table 2.2.1.3 Kirkman's Cove Lake Stakeholder Defined Water Quality Goals

TSI Parameter	Desired In-Lake Condition (growing season)	TSI Score	Mean TSI Score
Transparency (Secchi depth)	20 inches (0.51 meters)	69.7	****
Chlorophyll *a*	14.3 mg/m^3	56.7	****
Total phosphorus	95 µg/l	69.8	****
			65.4

Ultimately, the public will decide if a waterbody is aesthetically acceptable or un-acceptable. However, the stakeholder defined goals in this case will not result in the waterbody being deemed fully supporting the beneficial uses. Therefore, the goals/endpoint established by the Kirkman's Cove Lake Water Quality Advisory Council will be considered interim goals with the endpoint being those conditions necessary to achieve "full support".

2.2.2 Selection of Critical Environmental Conditions

The "critical condition" for which this nutrient TMDL applies is the entire year. An annual loading period was utilized in modeling Kirkman's Cove Lake's assimilative capacity and for estimating loading reductions necessary to meet in-lake water quality targets. This approach also takes into consideration that nutrients being lost from the water column and trapped in the bottom sediments have the potential to re-enter the water column at a later time. However, implementation of non-point source controls will target those times when a large percent of the loading is occurring.

2.2.3 Waterbody Pollutant Loading Capacity

The loading capacity for this nutrient TMDL is defined as the amount of phosphorus Kirkman's Cove Lake can receive on an annual basis and still meet the applicable water quality criteria, assigned beneficial use criteria and established in-lake water quality targets. Utilizing the EUTROMOD (Reckhow 1992) model, to meet the secchi, chlorophyll *a* and phosphorus goals (mean TSI ≤60), the phosphorus loading capacity for Kirkman's Cove Lake is 777.8 lbs/year (353 kg/year) (Appendix B).

2.3 Pollutant Assessment

For this TMDL, the pollutant assessment is based upon the water quality information collected from Kirkman's Cove Lake (deep water site) and from empirical data collected from Kirkham Creek (prior to the completion of the reservoir) and the inflow to Kirkman's Cove Lake.

2.3.1 Existing Pollutant Concentration and Load

As stated in section 2.1.3.1 the existing long-term average in-lake phosphorus concentration is 205.7 µg/l (0.2057 mg/l). The calculated annual phosphorus load delivered to Kirkman's Cove Lake is 3463.4 lbs/year (1571 kg/year). A description of the load calculation can be found in Appendix C.

2.3.2 Deviance From Desired In-lake Pollutant Concentration and Loading Capacity

In order to meet all of the in-lake goals (total phosphorus, chlorophyll *a* and secchi depth) the average annual total phosphorus concentration must be reduced from 205.7µg/l to 46.1 µg/l. To accomplish this the existing load must be reduced by approximately 79%.

2.3.3 Identification of Pollutant Sources

Because no point sources have been identified in the Kirkman's Cove Lake watershed, the pollutant load is believed to originate from nonpoint sources. It should be noted that within the watershed, two animal feeding operations have been issued state operating permits. These permits prohibit the discharge of pollutant to waters of the state and require facilities to contain all pollutants and nutrient management plans for the beneficial reuse of manure. For the purposes of this phosphorus TMDL, these will not be considered point sources, subject to WLA calculation and restriction.

Typically, areas with high sediment yields also produce significant phosphorus loads. The 1992-93 land uses indicate approximately 80% of the watershed is devoted to agriculture purposes (crop or pasture). As well, stream bank, gully and shoreline erosion should be considered phosphorus sources.

2.3.4 Linkage of Sources to Endpoints

The average annual load of 3463.4 lbs/year is the sum of the nonpoint source (watershed) load of 3410.6 lbs/year and the natural background (precipitation) load of 52.8 lbs/year.

2.4 Pollutant Allocation

A TMDL is defined as:

$$\text{TMDL} = \text{Loading Capacity} = \text{WLA} + \text{LA} + \text{Background} + \text{MOS}$$

As stated above, the phosphorus loading capacity for Kirkman's Cove Lake is 777.8 lbs/year (353 kgs/year). To achieve the defined phosphorus loading capacity the required allocations are contained in the following sections.

2.4.1 Wasteload Allocation

No point sources of phosphorus discharge in the Kirkman's Lake watershed therefore the wasteload allocation (WLA) will be "zero" (0).

2.4.2 Load Allocation

The phosphorus load allocation distributed among the nonpoint sources within the watershed will be 725 lbs/year (328.86 kg/year).

2.4.3 Natural Background

Utilizing annual precipitation, waterbody surface area and precipitation phosphorus concentration the natural background load of phosphorus was determined to be approximately 52.8 lbs/year (23.94 kg/year).

2.4.4 Margin of Safety

The margin of safety for the nutrient TMDL will be: phosphorus can be discharged from the Kirkman's Cove Lake/Reservoir outlet without being utilized. While this reduction is realized in the system, the TMDL will not account for this and assume the phosphorus load delivered to the lake remains available for algae production.

2.4.5 Nutrient (Phosphorus) TMDL Summary

TMDL/Waterbody Loading Capacity = 0 lbs/year (WLA) + 725 lbs/year (LA) + 52.8 lbs/year (Natural Background) + Implicit Margin of Safety

3.0 Implementation Plan

The implementation plan to meet the water quality goals for Kirkman's Cove Lake has been segregated into to two parts: 1) physical structures/treatment and 2) watershed treatments.

In 1995-96, rehabilitation at Kirkman's Cove Lake was completed and during that process the following actions were taken and or structure was created:

- Shoreline stabilization
- Sediment basin

The second part of the process includes the verification/identification of critical erosion areas (as defined by the AGNPS (Young 1987) modeling) and contributors and installing the watershed treatments necessary to control the load. This process will not only reduce the overall load to Kirkman's Cove Lake but will also increase the lifespan and efficiencies of the in-lake treatments.

To promote and facilitate implementation, the NNRD expects to complete a community based watershed management plan in Fall 2002. Within the plan, goals and objectives (Appendix D) have been laid out, not only to address the impaired beneficial uses (aquatic life and aesthetic), but all assigned beneficial uses. Along with this, the NNRD has recently added a watershed coordinator to the staff who will be responsible for implementation of the community based watershed management plan. Support for this position is being made through Section 319 funds. The NNRD in conjunction with the Natural Resource Conservation Service (NRCS) will be working with the individual landowners in the watershed to implement control measures.

3.1 Interim Reduction Goal

The reductions identified in section 2.2.1 are based upon meeting the phosphorus TSI score of 60 and in doing this, 3 of 3 TSI parameters will be ≤ 60 resulting in a waterbody assessment of full support. The driving factor in determining the reduction necessary is the assumption that the TSI score of 60 defines hypereutrophic conditions. In order to effectively manage the lake resources, differences in water quality due to hydrology, geographic location and physical morphology must be evaluated.

Rather than rely upon Carlson's definition of hypereutrophic (Carlson and Simpson 1996), the NDEQ, using Section 319 funds, has contracted with the University of Nebraska to develop a State of Nebraska lake classification system. The intent of project is to develop a statewide lake classification system and methodologies to evaluate water quality that are specific to a group of lakes or (eco)region. The classification system will be based on physical, chemical and biological information.

The result of this classification system may differ from Carlson's and a modification of the nutrient TMDL may be necessary. However, it is unclear when the classification system will be final and the NDEQ does not want to hinder the watershed management process with this uncertainty. Rather than delay the TMDL or community based planning process, implementation will initially strive to meet interim water quality and pollutant load reduction goals. Once these goals are met, the data collected (See Section 4.0) will be assessed to determine Kirkman's Cove Lake's beneficial use status. For this TMDL the interim goals will be to meet the stakeholder-defined goals for: in-lake phosphorus concentration, chlorophyll *a* concentration and water transparency (secchi depth). Meeting this goal will require a 50% reduction in the estimated load of 3463.4 lbs/year (annual loading capacity = 1731.7 lbs) (Appendix E).

It should noted, this goal is only an interim (implementation) goal with the final goal being the load allocation of 240 lbs/year stated in Section 2.4.2. In the future, should this load allocation be deemed inappropriate, a modification will be made to the TMDL and submitted to EPA for approval/disapproval.

3.2 Reasonable Assurances

Effective management of nonpoint source pollution in Nebraska necessarily requires a cooperative and coordinated effort by many agencies and organizations, both public and private. Each organization is uniquely equipped to deliver specific services and assistance to the citizens of Nebraska to help reduce the effects of nonpoint source pollution on the State's water resources. Appendix A lists those entities that may be included in the implementation process. These agencies have been identified as being responsible for program oversight or fund allocation that may be useful in addressing and reducing sedimentation and nutrient delivery to Kirkman's Cove Lake. Participation will depend on the agency/organization's program capabilities.

4.0 Future Monitoring

Monitoring of Kirkman's Cove Lake will be conducted in the future to determine if the water quality is improving, degrading or remaining status quo. As well, monitoring will be conducted to evaluate the effectiveness of implemented best management practices (BMPs). At this time the NDEQ has maintained the responsibility for collection of the monitoring data and information however, in the future, the NNRD may conduct the monitoring. As well, the NDEQ (or other entity) will periodically evaluate the impacts of sedimentation (bathymetry). Regardless of the source, data obtained from Kirkman's Cove Lake will be used in assessment of the beneficial use status.

5.0 Public Participation

Public participation for this TMDL was initiated in the form of the *Community Based Approach to the Watershed Management Planning Process* (CBPP) sponsored by the NNRD. The CBPP is a comprehensive problem solving process that integrates social, economical, and ecological concerns over a defined geographical area. The process strives to sustain and improve environmental heal through natural resource management approach that integrates locally driven initiative. The CBPP included several public and committee meetings where the local stakeholders were presented the water quality data, management options, etc. and resulted in the establishment of the locally derived water quality goals for Kirkman's Cove Lake.

Along with the CBPP, the availability of the TMDLs in draft form was published in the Humboldt Standard (printed August 1, 2002) Lincoln Journal Star (printed August 3, 2002) and the Falls City Journal (printed August 2, 2002) with the with the public comment period running from August 1, 2002 to September 4, 2002. These TMDLs were also made available to the public on the NDEQ's Internet site and announcement letters were mailed to interested stakeholders.

One comment letter was received from the United States Fish and Wildlife Service regarding the lack of a TMDL for atrazine and the applicability of the water quality criterion. The comment is not applicable to the TMDL and is a water quality standards issue therefore, no modifications or additions were made to the document as a result of the comment.

6.0 References

Carlson, R.E. 1977. A Trophic State Index for Lakes. *Limnology and Oceanography* 25:378-382.

Carlson, R.E. and J. Simpson. 1996 A coordinator's guide to volunteer monitoring methods. North American Lake Management Society and the Educational Foundation of North America.

Chapman, Shannen, S. Omernik, J.M., Freeouf, J.A., Huggins, D.G., McCauley, J.R., Freeman, C.C., Steiner, G.A., Robert, T., Schlepp, R.L., 2001. Ecoregions of Nebraska and Kansas (color poster with map, descriptive text, summary tables and photographs): Reston, Virginia, U.S. Geological Survey

NDEQ 2000. Title 117 – Nebraska Surface Water Quality Standards. Nebraska Department of Environmental Quality. Lincoln, NE.

NDEQ 1998. 1998 Section 303(d) List of Impaired Waters. Nebraska Department of Environmental Quality. Lincoln, NE.

NNRC. 1976. Nemaha River Basin Water Quality Management Plan. Nebraska Natural Resources Commission. Lincoln, NE.

NDNR. ____. Nebraska Department of Natural Resources Databank, NDNR Internet Site, Nebraska Department of Natural Resources. Lincoln, NE.

NNRD. 1994. Completion Report. Diagnostic/Feasibility Study – 1992, Kirkman's Cove Lake, Richardson County, NE. Prepared by EA Engineering Science, and Technology, Inc. Lincoln, NE.

Reckhow, K.H. 1992 EUTROMOD Nutrient Loading and Lake Eutrophication Model. Duke University School of the Environment. Durham, North Carolina.

Sautter, H.E. and A.D. Kuhl. 1974. Soil Survey of Richardson County Nebraska. USDA Soil Conservation Service. Lincoln, NE.

USEPA 1999. Protocol for Developing Nutrient TMDLs. United States Environmental Protection Agency. Office of Water, 4503 F, Washington, DC.

Young, R.A., Onstad, C.A., Bosch, D.D., Anderson, W.P. 1987. AGNPS, Agriculture Nonpoint Source Pollution Model, A Watershed Analysis Tool. Cons. Res. Rpt. 35. Agr. Res. Serv., U.S. Dept. Agr., Washington, D.C. 77pp**.**

Appendix A – Federal, State Agency and Private Organizations Included in TMDL Implementation.

FEDERAL

- Bureau of Reclamation
- Environmental Protection Agency
- Fish and Wildlife Service
- Geological Survey
- Department of Agriculture - Farm Services Agency
- Department of Agriculture - Natural Resources Conservation Service

STATE

- Association of Resources Districts
- Department of Agriculture
- Department of Environmental Quality
- Department of Roads
- Department of Water Resources
- Department of Health and Human Services
- Environmental Trust
- Game and Parks Commission
- Natural Resources Commission
- University of Nebraska Institute of Agriculture and Natural Resources (IANR)
- UN-IANR: Agricultural Research Division
- UN-IANR: Cooperative Extension Division
- UN-IANR: Conservation and Survey Division
- UN-IANR: Nebraska Forest Service
- UN-IANR: Water Center and Environmental Programs

LOCAL

- Natural Resources Districts
- County Governments (Zoning Board)
- City/Village Governments

NON-GOVERNMENTAL ORGANIZATIONS

- Nebraska Wildlife Federation
- Pheasants Forever
- Nebraska Water Environment Association
- Nebraska Corn Growers Association, Wheat Growers, etc.
- Nebraska Cattlemen's Association, Pork Producers, etc
- Other specialty interest groups
- Local Associations (i.e. homeowners associations)

Appendix B – EUTROMOD Model Output to Meet Beneficial Use Full Support

Kirkman's Cove Lake Full Support	Input data in green cells		Phosphorus (mg/l)	Chlorophyll *a*	Secchi Depth	Secchi Depth (inches)
Surface Acres (acres)	141.2	Monitored In-lake Value	0.0480	20	0.99	39
Lake Volume (ac-ft)	1457.8	Predicted	0.0461	11.70	0.659	25.94
Inflow (ac-ft/year)	2982.7	% Similar	0.96	0.59	0.67	
Inflow (cfs)						
Annual Precipitation	33.0		TSI - phosphorus	TSI - chlorophyll *a*	TSI - secchi	MEAN TSI
Watershed P Loading (lbs)	725	Monitored In-lake Value	60.0	60.0	60.1	60.0
Detention Time (years)	*0.49*	Predicted	59.4	54.7	66.0	60.0
Lake Volume (10^6 m^3)	*1.798*	% Similar	0.99	0.91	0.91	1.00
Volumetric Water Load (10^6 m^3/yr)	*3.680*					
Mean Depth (ft)	*10.32*		Watershed load to meet in-lake p concentration (lbs)	Watershed load to meet in-lake Chlorophyll *a* (lbs)	Watershed load to meet in-lake secchi (lbs)	
Mean Depth (m)	*3.147*		780	14000	240	
Watershed P Loading (kg)	328.86		Load Summary			
Precip P Load (kg)	*23.94*		Minimum	240		
Septic P Load (kg)			Mean	5007		
WWTF P Load (kg)			Median	780		
Total P Loading (kg)	*353*		Maximum	14000		
Total P Loading (lbs)	*777.78*					
Expected Total P-in	*0.096*					

Appendix C – Calculation of the Average Annual Phosphorus Load

In order to complete the total maximum daily load (TMDL) and the community based watershed management plan a long term; average annual pollutant load is needed. Ideally, this load estimate is obtained through long-term water quality and stream flow monitoring. In many cases, data is insufficient to account for the fluctuating climatic and environmental conditions and water quality managers must rely on models or other methods. For Kirkman's Cove however, water quality data from the inflow and tributary was available for use but first the data must be screened to determine if the information accounts for the environmental variations.

Because a load (mass x volume) would be calculated, stream flow volume from the tributary is necessary. Unfortunately, there is no information indicating a water volume gage has been located on Kirkham Creek. In the past USGS and/or the Department of Water Resources (Natural Resource) did operate two gages in the vicinity, one on Muddy Creek near Verdon and one on the North Fork of the Big Nemaha River at Humboldt. Table C.1 presents some of the gage site information.

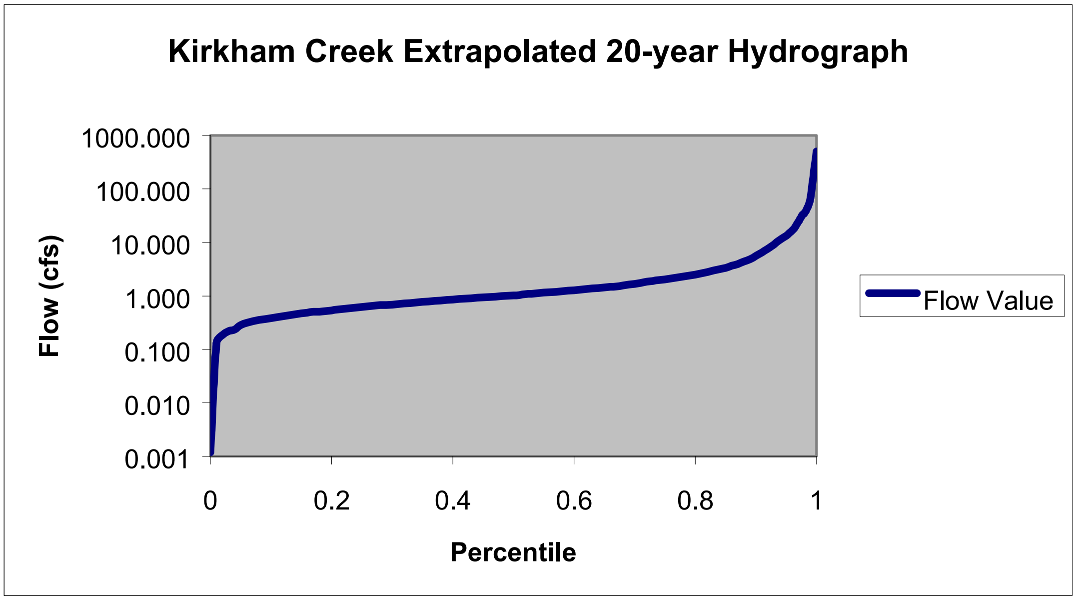
Table C1 Gage in Close Proximity to Kirkman's Cove Lake and Kirkham Creek

	North Fork Big Nemaha at Humboldt	Muddy Creek at Verdon
Gage ID Number	06814500	06815500
Period of Record	1/1/52 to 9/30/96	1/1/52 to 9/30/96
Drainage Area	548 mi^2	188 mi^2

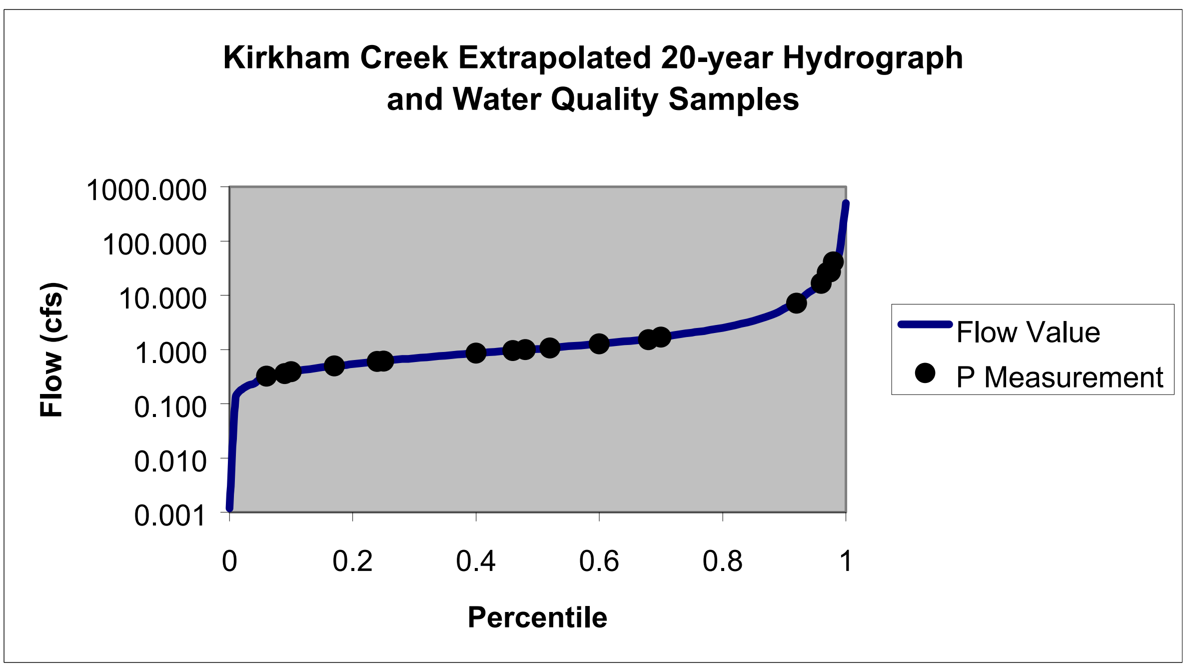
One method of estimating stream flow is to utilize a watershed/drainage ratio. The assumptions are that land use, precipitation, drainage patterns, etc. are similar between watersheds in the same general area and thus the stream flow volume would be directly related to the watershed size. The Kirkham Creek watershed (9.19 mi^2) is significantly smaller than either of the two selected however, rather than based the selection decision on size, it was decided that the most current period of record be chosen for extrapolation purposes.

Because the size of the North Fork Big Nemaha River at Humboldt watershed is significantly larger than Kirkham Creek's, a comparison of the extrapolation method was conducted using existing information from Muddy Creek and the North Fork. The comparison considered the actual measured flow of Muddy Creek at Verdon and the extrapolated flow using the watershed ratio. The average measured flow for the period of record (1952-1972) was 66.3 cfs and the extrapolated flow was 59.5 cfs. With the extrapolated and measured flows being 90% similar, the use of the North Fork Big Nemaha River at Humboldt appears appropriate.

In order to be consistent with the development of other design flows, the data set was reduced to the most recent 20 years. The watershed ratio or percentage was calculated simply by dividing the Kirkham Creek drainage by the North Fork of the Big Nemaha River at Humboldt drainage. (9.19 $mi^2 \div$ 588 mi^2 = 0.01563). The percentage value was then multiplied by the average daily flows measured on the North Fork Big Nemaha River at Humboldt and the results are extrapolated average daily flow values for Kirkham Creek. From this data set, the below hydrograph was generated.



For the TMDL, reductions and implementation of pollutant controls, the estimated load must be expressed as an annual load. To achieve this, the data utilized must be reflective of the various conditions that may occur such. For streams in southeast Nebraska, variations in weather can often be reflected by stream flow. That is, high flows indicate precipitation (run-off) events while low flows reflect base-line conditions. To determine if the data was collected under the various conditions, the extrapolated flow on the day of sample was plotted on the hydrograph for the 18 monitoring points. The results are presented in the chart below.



The minimum and maximum flows of the water quality samples are approximately equal to the 6th and 98th percentile flows, respectively and as shown on the graph, the remainder of the samples is distributed fairly well across the hydrograph. The conclusion of this evaluation is that the existing samples represent the water quality of Kirkham Creek and can be used to determine an annual condition.

Therefore, the average annual flow was determined using: the long term average daily flow of the extrapolated data set and the average total phosphorus concentration of the existing data. The equation is as follows:

Annual Average (Watershed) Phosphorus Load = (0.42 mg/l x 4.12 cfs x 5.4) x 365 days/year
= 3410.6 lbs/year

The EUTROMOD model (Appendix B) estimated the phosphorus load from precipitation to be 52.7 lbs/year (23.9 kg/year). This plus the watershed load of 3410.6 combines for a total phosphorus load of 3463.3 lbs/year.

Appendix D – Goal and Objectives of the Community Based Watershed Management Plan

Goal 1. Achieve and maintain a full support status for the beneficial uses assigned to Kirkman's Cove Reservoir.

Aquatic Life Use

Objective 1. Increase the average dissolved oxygen concentration at the deepwater site above 5.0 mg/l.

Objective 2. Decrease average summer total phosphorus concentrations at the deepwater site to 0.095 mg/l.

Objective 3. Maintain levels of pesticides and heavy metals at the deepwater site below water chronic standards concentrations.

Recreation Use

Objective 4. Maintain concentrations of fecal coliform bacteria at the deepwater site below water quality standards concentrations.

Aesthetics

Objective 5. Maintain average summer chlorophyll concentrations at the deepwater site below 14.3 mg/m^3.

Objective 6. Increase average summer water transparency measurements at the deepwater site 20 inches.

Objective 7. Maintain average annual sediment loads delivered to Kirkman's Cove Reservoir below 16,474 tons.

Agricultural Water Supplies

Objective 8. Maintain concentrations of nitrate nitrogen and selenium below chronic water quality standards.

Goal 2. Educate landowners, agricultural producers, recreational users, and others on the importance of watershed stewardship and good water quality.

Objective 9. Inform 100% of the landowners and producers in the watershed about available opportunities to improve their operation and downstream water quality through one on one contact.

Objective 10. Initiate demonstration projects for major treatment practices.

Objective 11. Inform recreational users of the reservoir about opportunities to have a positive impact on water quality.

Objective 12. Increase youth awareness of water quality.

Goal 3. Improve economic incentives that are available to watershed landowners and operators.

Objective 13. Establish the Kirkman's Cove watershed as a high priority for government programs.

Objective 14. Develop new opportunities that are innovative and economically and technically sound that can be used to address water quality issues.

Goal 4. Maintain the existing quality of groundwater in the watershed.

Objective 15. Establish a groundwater quality monitoring and evaluation program.\

Objective 16. Reduce surface contributions of nitrogen to groundwater.

Objective 17. Reduce surface contributions of bacteria to groundwater.

Objective 18. Reduce surface contributions of pesticides to groundwater.

Objective 19. Provide information and educational activities related to groundwater quality.

Appendix E – EUTROMOD Model Output to Meet Interim (Implementation) Reduction Goals

Kirkman's Cove Lake Interim Reduction	Input data in green cells		Phosphorus (mg/l)	Chlorophyll *a*	Secchi Depth	Secchi Depth (inches)
Reduction %	50	Predicted	0.0682	14.29	0.51	20.1
Lake Volume (ac-ft)	1457.8	Water Quality Goals	0.0950	14.3	0.51	20
Surface Acres (acres)	141.2	% Similar	0.72	0.18	1.00	
Detention Time (years)	0.49					
Watershed P Loading (lbs)	3410.62		TSI - phosphorus	TSI – chlorophyll *a*	TSI - secchi	MEAN TSI
Reduced Watershed Load (lbs)	*1705.3*	Predicted	65.0	56.7	69.7	63.8
Volumetric Water Load (10^6 m^3/yr)	*3.680*	Water Quality Goals	69.8	56.7	69.7	65.4
Lake Volume (10^6 m^3)	*1.798*	% Similar	0.93	0.77	1.00	0.90
Mean Depth (ft)	*10.32*					
Mean Depth (m)	*3.147*		Phosphorus load Reduction to meet p concentration water quality goal (lbs)	Phosphorus load reduction to meet Chlorophyll *a* water quality goal (lbs)	Phosphorus load reduction to meet secchi measurement goal (lbs)	
Watershed P Loading (kg)	1547					
Precip P Load (kg)	23.9		Reduction Summary			
Septic P Load (kg)	*0*		Minimum	0		
WWTF P Load (kg)	*0*		Mean	#DIV/0!		
Total Reduced P Loading (kg)	*785.5*		Median	#NUM!		
Total Reduced P Loading (lbs)	*1731.7*		Maximum	0		
Expected Total P-in	*0.213*					